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MACROINVERTEBRATE FAUNA OF A TROPICAL SOUTHERN RESERVOIR, EKITI STATE, NIGERIA.

J.B. Edward[1], and A.A.A. Ugwumba[2]
[1] Department of Zoology, University of Ado Ekiti, P.M.B. 5363, Ado Ekiti Ekiti State, Nigeria.
[2] Department of Zoology, University of Ibadan, Oyo State, Nigeria.

ABSTRACT
A survey of the macroinvertebrate fauna of Egbe Reservoir, Ekiti State, Nigeria was carried out. Sampling of surface waters and macroinvertebrates was carried out twice in a month from September 2004 to December 2006. Physico-chemical parameters determined include pH, conductivity, alkalinity, dissolved oxygen and biochemical oxygen demand (BOD) using APHA methods. Macroinvertebrates were collected by kick sampling and with Van veen grab. Data analysis was done using descriptive statistics, Duncan multiple range, pearson correlation, paired t tests and diversity indices. Eighteen taxa of macroinvertebrates in two Phyla of Mollusca and Arthropoda were identified. Gastropods had the highest numerical abundance (41.8 %), diversity (d= 0.61, H=1.56) and evenness (J=0.87). Odonata and Ephemeroptera (Insecta) had the lowest diversity (d=0.00, H= 0.00 and d= 0.14, H= 0.13) and numerical abundance (0.4% and 6.3%, respectively). The gastropod, *Melanoides tuberculata*, which is the most abundant macroinvertebrate is an indicator of polluted water. This suggests that the reservoir may be tending towards organic pollution. This is further confirmed by the low abundance of Ephemeroptera and Odonata which are indicators of clean water. Measures should be taken to prevent the reservoir from further deterioration and eventual eutrophication.

KEYWORDS: Macroinvertebrates, Egbe Reservoir, Pollution.

INTRODUCTION

Macroinvertebrates are important at the food web of aquatic ecosystems. Benthic dipteran larvae e.g. *Chironomus* species and mollusks are consumed in great quantities by many fishes and so play an important role in the ecology of the aquatic ecosystems as shown by a lot of works on food and feeding habits of some freshwater fishes (Imevbore and Bakare, 1970; Ogari and Dadzie, 1987; Fagade and Olaniyan, 1973 and Ugwumba and Ikusemiju, 1994). They have being used to assess the biological productivity of lakes and rivers (Mehmet *et. al*., 2002). Freshwaters are being polluted and facing various limnological problems due to increasing anthropogenic activities. Benthic invertebrates are used in determining and observing eutrophication, pollution and water quality, and many of them have been accepted as biomonitor species. Their diversity and abundance is a reflection of the quality of water and its sediments.

There are many studies in various parts of the world on the benthic macroinvertebrates of freshwater bodies. These include the works of Petr (1970) on the bottom fauna of the rapids of Black Volta River in Ghana, Johnson and Brinkhurst (1976) on Quinte Lake, Ontario, Canada; Darlington (1977) on Lake George in Uganda. In Nigeria, Victor and Dickson (1985) worked on macroinvertebrates of a perturbed stream in southern Nigeria; Adebisi (1989) studied the planktonic and benthic organisms of Olupona fish farm, Ibadan, Oyo State; Oke (1998) worked on the limnology and macrobenthos of Owena Reservoir in Ondo State; Ogbeibu and Oribharbor (2002) on the upper reaches of Ikpoba River; Victor and Ogbeibu (1985a and b); Victor and Dickson (1985) and Ogbeibu and Victor (1989) on some southern steams. Presently, no studies have been conducted on the general benthic fauna of any stream or river in Ekiti State. Yet, this area lies within the tropical rainforest expected to have a high diversity of aquatic organisms. This present study was therefore carried out to provide some baseline information on the composition, seasonal abundance and distribution of the benthic fauna of Egbe Reservoir, Ekiti State.

Study Area

Egbe Reservoir is the major source of domestic water supply to the people of Gbonyin Local Government Area of Ekiti State and parts of Ondo State, mainly the Akoko areas (Fig. 1). The reservoir also serves as a source of

irrigation of farmed lands as well as a means of livelihood for the local fishermen who depend mainly on the fishery resources of the reservoir.

The reservoir was formed as a result of damming the River Osse, a major river that takes its source from Kwara State and runs through Ekiti to Ondo States. The river was dammed at Egbe Ekiti, and was constructed in 1975 and commissioned in 1989. The transverse survey is 272.5 hectares and the depth of the reservoir is 56.4m at its deepest point . The reservoir is located on an undulating plane and lies between latitudes 7°36'N and $7^0$39' North and longitude 5°32'E and $5^0$36' East of the Equator as shown in Figure 1. It is surrounded by highlands from which runoffs also feed the reservoir during raining season. The bottom substratum of the reservoir is rocky.

Four sampling stations were chosen in the reservoir. Station 1 (Dam station) is about 200m from the water treatment house of the reservoir. Vegetation around this station is mainly grasses and various species of birds including cattle egrets frequent this site, perching on the rocks. Activity around here includes only cattle grazing. Station 2 (Rocky station) is 399m from station 1. The area has thick vegetation comprising mainly of palm trees.

The major activities around here are farming and fishing. Station 3 (Bridge station) is located along the road, close to a bridge and is 450m to station 2. This area also has thick vegetation cover and the major activities around here include farming, fishing and car washing and laundering. Station 4 (River Osse inlet station) is about 300m from the previous site and is bounded by vegetation. Water birds also frequent this site and activities around this place include farming, fishing, cattle grazing, bathing and laundering. Virtually all the available landmass around the reservoir and its environs is essentially used for agricultural activities. Some of the local fishermen also build their huts close to the reservoir. These areas also have high density of animal confinement, rocks, and coastal plain sands.

The Reservoir is surrounded on each side by a stretch of thick forest made up of trees like *Chlorophora excelsa* (African teak, "Iroko"), *Terminalia Superba* (Limba "Afara") and *Senna occidentalis* - coffee. Floating plants include *Ceratophyllum*

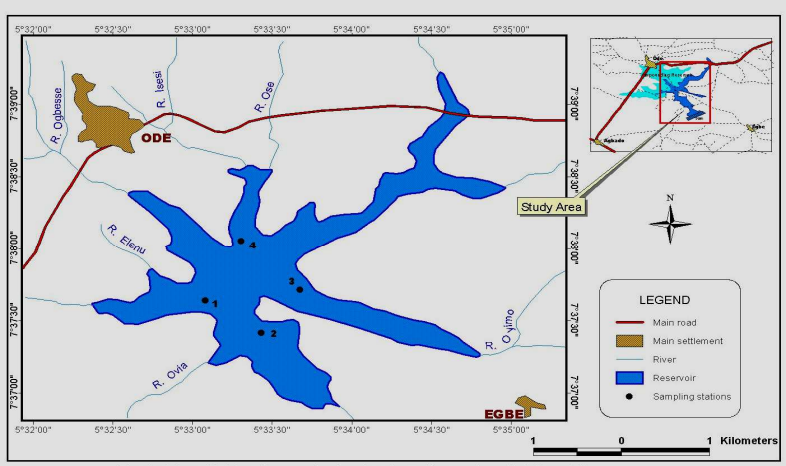

Fig. 1 : Map of Egbe Reservoir showing Sampling stations(1,2,3,and 4).

Figure 1: Egbe Ekiti showing the location of the reservoir and the sampling stations

submersum, Mormodica balsamina (Balsaam pear), *Commelina diffusa* waterside Commelina), *Cyperus articulatus* (Sedge) and *Pistia stratioles.* Weeds at the bank of the Reservoir include *Chromolaena odorata* (Siam weed), *Aspilia africana* (Bush marigold), and *Cynodon plectostachynm.*

The Reservoir also supports a commercial fishery of about twenty-five fishermen fishing daily with traps, sets and cast nets, hook and line. However, only nine of these fishermen were available during this period of study. Fish species in the Reservoir include *Tilapia zillii, Oreochromis niloticus, Channa obscurus, Clarias gariepinus, C. anguillaris, Hepsetus odoe, Sarotherodon melanopteron*, and *Mormyrus* sp.

MATERIALS AND METHODS

Macroinvertebrate Sampling and Identification

Kick sampling method was used to collect the macroinvertebrates of the river bank sediments. This method was carried out by using a stick to agitate $1m^2$ area of the substratum. The dislodged macroinvertebrates that moved downstream were then collected with a 150μm mesh size net held against the water current with the mouth facing upstream. Three replicate samples were collected at each sampled station.

In the laboratory, the sediments collected were washed through graduated sieves of 0.5mm, 1mm, 2mm, and 3mm. The washed sediments with macroinvertebrates were poured into a white tray and sorted out. Sorting of the macroinvertebrates in the sediment sample was enhanced by staining the washed sediment samples with Rose Bengal solution. The macroinvertebrates collected from each station were then sorted into different taxonomic groups using a x 10 scanning lens. Each taxonomic group was placed in a specimen bottle containing 4% formalin and properly labeled. The macroinvertebrates were later identified to genus or species level where possible with a compound microscope using identification guides of Pennak (1978), APHA / AWWA / WPCF (1992) and Yoloye (1994). Each identified taxon was counted and the number of individuals recorded per unit area.

RESULTS

The macroinvertebrates identified in Egbe Reservoir are listed in Table 1 showed the checklist and data on the numerical abundance and percentage composition by number of macrobenthic invertebrates from the various sampling stations for the overall as well as the dry and rainy season of the study period.

Eighteen (18) macroinvertebrate genera were identified and they were of two phyla of Mollusca and Arthropoda. The Mollusca were all of one class of gastropoda (pond snails). Arthropoda were represented by two classes, Arachnida represented by one genera of Hydracarina and Insecta, represented by four orders of Odonata, Diptera, Hemiptera and Ephemeroptera.

The macroinvertebrates of the reservoir was dominated by the gastropoda with five species and one genus. They constituted 41.8% of the total number of macroinvertebrates (Fig 2). Amongst them, *Melanoides tuberculata* had the highest percentage composition (14.2%) followed by *Bulinus globossus* (8.9%). The least abundant gastropod was *Gabiella* sp. which made up 1.2% of the total number of macroinvertebrate.

Amongst the Arthropods, the Order Diptera is the most dominant Insect, comprising of four genera which made up 31.8% of the total macroinvertebrate abundance by number (Fig. 2). In this order, *Anopheles* larvae made up the highest percentage composition 25.3% of the total number of macroinvertebrate (Table 1). The least abundant insect in this order was *Tipula* sp. with 0.8% of the total macroinvertebrate population.

The order Hemiptera was next in abundance which was also made up of one species and three genera. It constituted 19.3% of the total number of macroinvertebrate (Fig. 2). *Notonecta* sp. was the most abundant making up 18.1% of the total macroinvertebrate by number. The least abundant was *Sigara* sp. constituting only 0.2% of the total macroinvertebrates (Table 1).

Ephemeroptera were represented by one species *Ephmerella excrucians* and one genus *Caenis* sp. They constituted 6.3% of the total number of macroinvertebrate (see Fig. 2). Odonata was represented by only one species of *Macromia magnifica* which had
the least percentage composition, 0.3% of the total macroinvertebrate by number.

The Class Arachnida was represented by only one genus *Hydracarina* of the order Acarina. It comprised the least percentage composition, 0.3% of the total number of macroinvertebrate of the reservoir.

Table1: Checklist, Numerical and percentage abundance of macroinvertebrates in Egbe Reservoir

Macroinvertebrate	Dry Season		Rainy Season		Overall	
Gastropoda (Pond snails)	Abund.	%	Abund.	%	Abund.	%
Melanoides tuberculata	1485	11.8	3659	15.4	5144	14.2
Bulinus globossus	1155	9.2	2094	8.8	3249	8.9
Lymnaea natalensis	1008	8.0	2119	8.9	3127	8.6
Biomphalaria pfeifferi	496	3.9	1895	8.0	2391	6.5
Physa waterlotti	148	1.2	711	3.0	859	2.4
Gabiella sp.	234	1.9	201	0.8	435	1.2
Total	4526	36.0	10679	44.9	15205	41.8
Diptera						
Anopheles larvae	3191	25.4	5997	25.2	9188	25.3
Palpomyia sp.	306	2.4	1441	6.1	1747	4.8
Symbiocladius sp.	0	0	323	1.4	323	0.9
Tipula sp.	103	0.8	180	0.8	283	0.8
Total	3600	28.6	7941	33.5	11541	31.8
Hemiptera						
Notonecta sp.	2893	23.0	3960	0.3	6583	18.1
Lethocerus americanus	83	0.7	148	0.7	231	0.6
Gerris sp.	46	0.5	89	15.4	135	0.4
Sigara sp.	30	0.2	33	0.1	63	0.2
Total	3052	24.4	3960	16.6	7012	19.3
Ephemeroptera						
Ephemerella excrucians	1211	9.6	1008	4.2	2219	6.1
Caenis sp.	47	0.4	53	0.2	100	0.2
Total	1258	10.0	1061	4.4	2319	6.3
Odonata						
Macromia magnifica	75	0.6	64	0.3	139	0.4
Total	75	0.6	64	0.3	139	0.4
Arachnida						
Hydracarina sp.	56	0.4	71	0.3	127	0.4
Total	56	0.4	71	0.3	127	0.4
Grand Total Abundance	12567	100	23776	100	36343	100

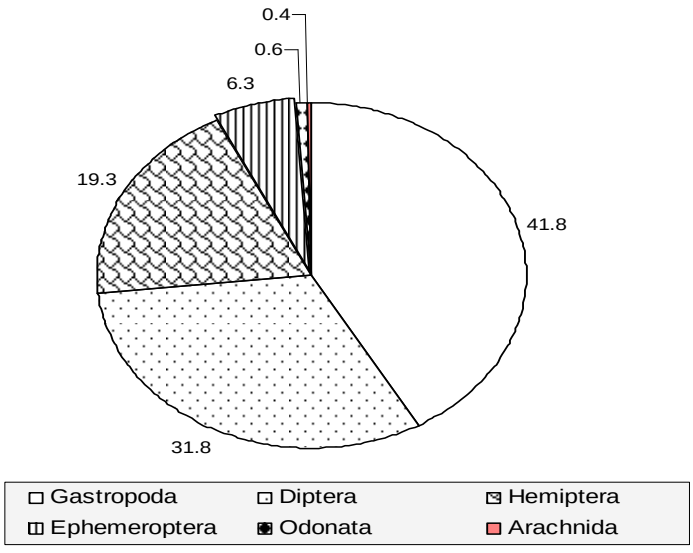

Figure 2: Relative abundance by number of macroinvertebrates in Egbe Reservoir during the period of study (Sept. 2005Dec. 2006).

Seasonal distribution of Macroinvertebrates

In the dry season gastropods still had the highest percentage composition by number 36.0% of the total number of macroinvertebrates (Fig. 3). *Melanoides tuberculata* was also the most abundant gastropod (11.8%), followed by *Bulinus globossus* (9.2%), and the least abundant was *Physa waterlottii* (1.9%) (Table 1). During the wet season, gastropods were higher in abundance constituting (44.9%) of the total number of macroinvertebrates (see Fig. 4.), with *Melanoides tuberculata* having the highest percentage composition, 15.4% by number of the total macroinvertebrate abundance. Next in abundance was *Lymnaea natalensis* which made up 8.9% of the total number of macroinvertebrates. The least abundant gastropod was *Gabiella* sp. comprising only 0.8% of the total number of macroinvertebrates (Table 1).

The Diptera made up 28.6% and 33.5% of the total number of macroinvertebrates during the dry and rainy seasons respectively (Figures 3 and 4). *Anopheles* larvae had the highest percentage composition (25.4% and 25.2%) during both dry and wet seasons respectively, while *Tipula* sp. also recorded the least abundance of 0.8% during both seasons (Table 1).

Hemiptera was higher in abundance during dry season constituting 24.4% of the total number of macroinvertebrates and 16.6% during rainy seasons (Figures 3 and 4). In this Order, *Notonecta* sp. was the most abundant making up 23.0% of the total number of macroinvertebrates during dry season and 15.5% during the rainy season (see Table 1). The least abundant Hemiptera was *Sigara* sp. constituting only 0.2% and 0.1% of the total number of macroinvertebrates during dry and rainy seasons respectively (Table 1).

Ephemerella excrucians an Ephemeroptera had higher percentage composition by number during both dry and wet seasons (9.6% and 4.4%) than *Caenis* sp. (0.4% and 0.2%, respectively,Table 1). The Odonata *Macromia magnifica* constituted the least percentage composition by number (0.6% and 0.3%) of Insecta during both dry and rainy seasons respectively. The Class Arachnida recorded the least percentage composition by number of macroinvertebrates (0.4% and 0.3%) during both dry and wet seasons respectively (see Table 1).

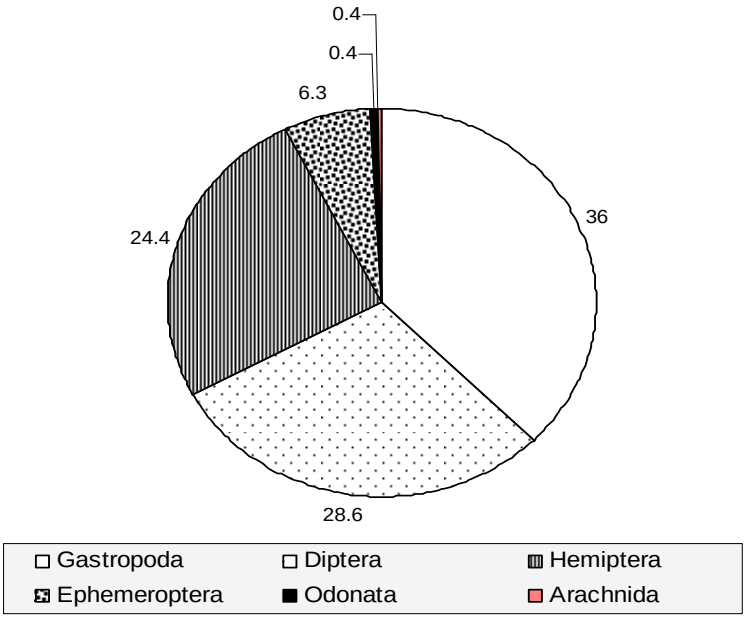

Figure 3: Relative abundance by number of macroinvertebrates in Egbe Reservoir during dry season

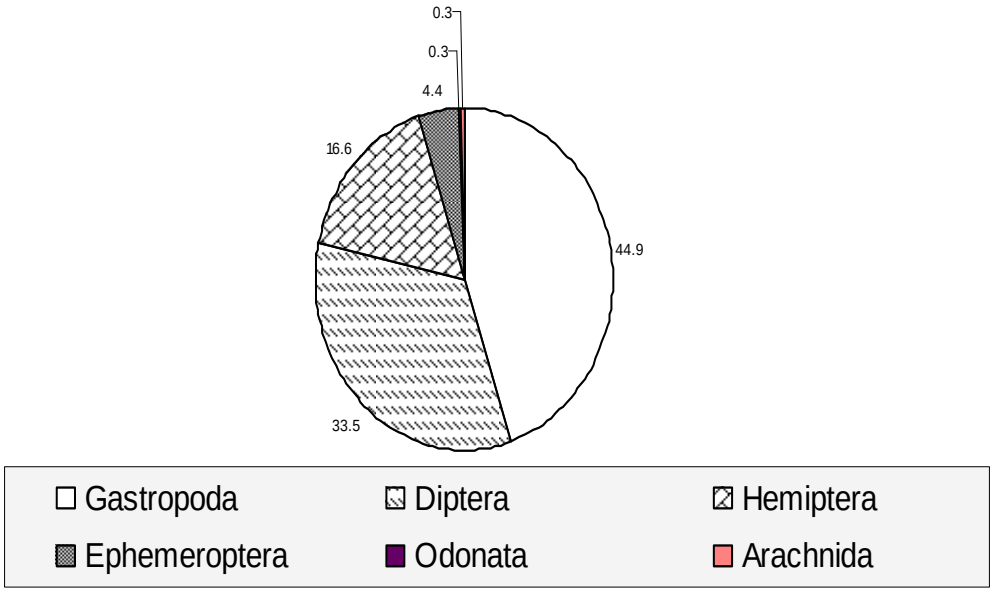

Figure 4: : Relative abundance by number of macroinvertebrates in Egbe Reservoir during rainy season

Spatially, gastropods were most abundant (43.7% by number) at the Rocky station and least (39.4% by number) at the Dam station. The Diptera had their highest (33.9%) composition by number also at the Rocky station and its least (28.1%) at the Inlet station. Hemiptera was highest in abundance numerically (23.4%) at the Inlet station and lowest (17.1%) at the Rocky station. Ephemeroptera had its highest numerical abundance (8.0%) at the Dam station and the least (4.9%) at the Rocky station, while Odonata recorded 0.7% by number at the Bridge station and 0.2% at the Rocky station. Arachnida was the least abundant macroinvertebrate in all the sampled stations with 0.5% by number at the Dam station and 0.2% by number at the Inlet station (Fig. 5).

During the seasons, gastropods were also the most abundant macroinvertebrate numerically. They constituted the highest numerical percentage (40.0%) at the Bridge station and the least (32.9%) at the Inlet station during the dry season, while they had 46.5% by number at the Rocky station and the least 42.4% at the Dam station during the rainy season (Fig. 5). Diptera were next in abundance numerically. They recorded the highest composition by number (30.5%) at the Inlet station and the least 27.8% at the Dam station during the dry season. In the rainy season, their abundance was higher (36.6%) at the Dam station and least (26.7%) at the inlet station. Hemiptera was most abundant numerically (26.4%) at the Inlet station and least (21.5%) at the Bridge station during the dry season, while in the rainy season, it recorded 21.9% at the Inlet station and 13.5% at the Rocky station (Fig. 5).

Ephemeroptera were higher in abundance during the dry season in all the sampled stations. Its highest numerical abundance (12.8%) was recorded at the Dam station and the least (8.3%) at the Rocky station. During the rainy season, Ephemeroptera had 5.6% by number at the Bridge station and 3.5% both at the Rocky and Inlet stations. Odonata were also more in abundance in the dry season than in the rainy season, having its highest composition by number 0.9% at the Bridge station and the least 0.1% at the Rocky station, while in the rainy season, it recorded 0.6% by number also at the Bridge station and 0.1% at the Dam station. Arachnida was the least abundant macroinvertebrate during both seasons. It recorded 0.8% abundance by number at the Bridge station and 0.2% by number both at the Rocky and Inlet stations during the dry season. In the rainy season, it had 0.5% by number at the Dam station and 0.2% both at the Bridge and Inlet stations (Fig. 5).

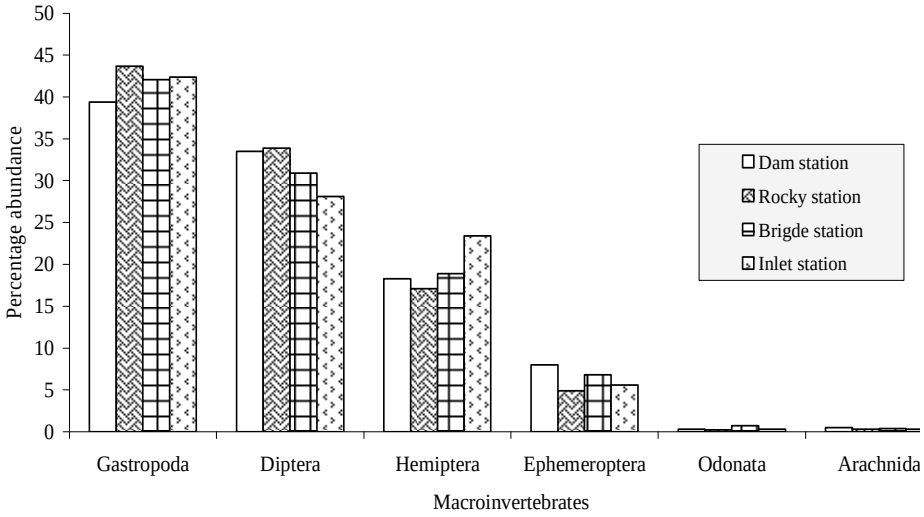

Figure 5: Percentage abundance by number of macroinvertebrates in the four stations of Egbe Reservoir during the period of study (Sept. 2005- Dec. 2006).

Macroinvertebrate Diversity

Tables 2-4 showed the macroinvertebrate diversity indices. Gastropoda generally had the highest diversity (d = 0.61; H = 1.56) and its equitability value was also high (J = 0.87) for the overall sample (Table 24). The next most diverse taxa were the Diptera (d = 0.38; H = 0.60) and Hemiptera (d= 0.41; H= 0.28). However, the Diptera was more evenly distributed (J= 0.43) than Hemiptera (J= 0.21).

During the seasons, a similar trend as above was also noticed. Gastropoda also exhibited the highest diversity during both rainy (d = 0.64; H = 156) and dry seasons (d = 0.72; H = 1.52). Its equitability values were also highest in both seasons, J = 0.87 and J = 0.85 for rainy and dry seasons respectively (Tables 3 and 4). Diptera were also the next most diverse and evenly distributed (d = 0.40; H = 0.66 and J = 0.48 for rainy and d = 0.72; H = 1.52 and J = 0.85 for the dry seasons).

The pattern of diversity and distribution observed above was also evident among the five locations of the reservoir. That is, gastropods still had the highest diversity and distribution, in the two seasons too, and were followed by the dipterans (see Table 3 and 4).

DISCUSSION

The macroinvertebrate fauna composition of Egbe Reservoir is characterized by low taxa number. This is not unusual in tropical waters; for instance, in Lake George, Uganda, the bottom fauna was poor in species (Darlington, 1977). Victor and Dickson (1985) and Umeozor (1996) also observed a similarly low taxa number and diversity in Ikpoba River and Calabar River, Nigeria respectively. Edokpayi *et al.* (2000), Ogbeibu (2001), Adakole and Annune (2003) also reported low taxa number in some tropical streams and rivers. They ascribed this low species diversity to some physico-chemical conditions of water like fast flow, high pH, low dissolved oxygen and low conductivity. These factors probably caused disruption of life cycle, reproductive cycle, food chain and migrations or imposed physiological stress on even the tolerant macroinvertebrate (Adakole and Annune, 2003).

However, in the case of Egbe Reservior, the low taxa number observed could in addition be due to factors other than physico-chemical conditions of the water such as habitat preference, resource partitioning, and food availability. For instance, Odum (1971) had reported that diversity tends to be low in physically controlled systems such as ponds and dams. This could be the case here in Egbe Reservoir because the artisanal fishermen regularly clear the waterways of macrophytes for smooth sailing of their boats.

Table 2: Diversity index values of macroinvertebrate during the period of study

Taxa	D	H	J
Gastropoda	0.61	1.56	0.87
Diptera	0.38	0.60	0.43
Hemiptera	0.41	0.28	0.21
Ephemeroptera	0.16	0.16	0.23

D= Margalef's diversity index, H= Shanon-Wiener's index, J= Equitability measure

Table 3: Diversity index values of macroinvertebrate during the dry and rainy seasons

	Dry Season			Rainy Season		
Taxa	D	H	J	D	H	J
Gastropoda	0.72	1.52	0.85	0.64	1.56	0.87
Diptera	0.29	0.40	0.37	0.40	0.66	0.48
Hemiptera	0.46	0.25	0.18	0.41	0.30	0.23
Ephemeroptera	0.14	0.13	0.18	0.18	0.20	0.26

D= Margalef's diversity index, H= Shanon-Wiener's index, J= Equitability measure

The aquatic macrophytes serves as habitats for most macroinvertebrates especially gastropods and their eggs. Influx of agrochemicals, bathing and laundry activities could also impact negatively on these aquatic fauna. These activities cause pollution of the water body and may affect species diversity of macroinvertebrates of the reservoir. Umeozor (1996) in his study on the new Calabar River reported that the important factors governing the occurrence and distribution of macroinvertebrates are the physico-chemical qualities of the water and the nature of immediate substrates. Any severe alterations of these factors will substantially affect the macroinvertebrate community. Bishop (1973) also reported that pollution in its total effect tends to disrupt the natural complexity and stability of an ecosystem and lead to a less stable state in which diversity is reduced and the self-regulating buffering capacity against change is diminished. It may therefore be implied in this study that as the waters of the reservoir is observed to be slightly polluted, this may have influenced the overall distribution of the benthic fauna.

The higher abundance of macroinvertebrates in the rainy season is contrary to the reports of Umeozor (1996) on the macroinvertebrate abundance in the New Calabar River; Zabbey (2002) on the benthic macroinvertebrates of Woji Creek off Bonny River, and Zikoki and Zabbey (2006) on the benthic community of the middle reaches of Imo River. These authors recorded a higher abundance of macroinvertebrates in the dry season than rainy season. They explained that during the rains, sedimentary particles become unstable causing dislodgement of the benthic animals. However, the gastropods and insecta that dominated the invertebrate population of Egbe Reservoir have been documented to be relatively tolerant of physical and chemical variations in the environment, and are present in a broad range of environment irrespective of the seasons (Ormerod, 1988).

The most important factors which influence the abundance and distribution of macroinvertebrates apart from physical and chemical qualities of water include habitat area, immediate substrate, trophic structure, resource partitioning and predation (Bishop, 1973; Ogbeibu and Victor, 1989, Ogbeibu and Egborge, 1995). Another important feature of freshwater systems that may account for the higher abundance recorded during the rainy season is that predators other than fish and aquatic invertebrates exploit invertebrate prey better in the dry season than they do in the rainy season. This is because in the dry season, the water level becomes reduced and clearer, the substrate also stabilizes and the population builds up, thereby making available for the fish and avian predators more prey items. Predatory losses to such carnivorous endotherms as birds can also be particularly high (Cooper *et al.,* 1991 Ormerod and Tyler, 1988). Different species of these water-loving birds were present around Egbe Reservoir. This factor may have contributed to the observed reduced abundance during the dry season.

Habitat preference among the invertebrates may be one of the chief factors responsible for the decrease in abundance with sampling stations. The substrate around the Dam station is rocky. It is located close to the base of a rock; and the bottom substrate is composed of coarsed sand and gravels; vegetation around here is mainly aquatic macrophytes like *Ceratophyllum* and *Nymphea*. Aquatic birds and cattle also frequent this site. Vegetation around the other stations are also aquatic macrophytes and often thick, though with varying bottom

substrates.

Other factors which may influence the abundance and distribution of invertebrates include the possible role of competition and resource partitioning, physical tolerances, and the trophic structure. These factors, coupled with habitat differences observed in this study probably acted singly or in combination to influence the variations in abundance of macroinvertebrates.

The low values of diversity indices may indicate decimating impact of impoundment on the benthic communities. Impoundment of water bodies have been known to have profound effect on the distribution and abundance of the resident organisms in Tropical waters (Egborge, 1977; 1979b; 1979c; 1981 and Ogbeibu *et al.*, 2002). The low values may also indicate pollutional stress which is further confirmed by the low eveness (J) values of all the sampled stations for Odonata and Ephemeroptera which are clean water insects. Abundance of macroinvertebrates in Egbe Reservoir revealed a distinct pattern of dominance: a lotic system which is characterized by single species dominance. This depicts a simple homogenous environment favouring the dominance of a single group, thus making the system less robust and fragile (Ogbeibu and Egborge, 1995).

REFERENCES

Adakole, J.A. and Annune, P.A. (2003). Benthic macroinvertebrates as indicators of environmental quality of an urban sream, Zaria, Northern Nigeria. *Journal of Aquatic Science.* 18: 85-92.

Adebisi (1989). Planktonic and Benthic Organisms in some ponds in the Olupona Fish Farm, Olupona, Oyo State. Nigeria. *A report prepared for Agro Team s.r.i.* Ibadan. Nigeria.

APHA, AWWA, WEF, (1992). *Standard Methods for the Examination of Water and Wastewater. American Public Health Association*, Greenberg, A.E., Clesceri, L.S., and Eaton, A.D., (eds) 18th Edition.

Bishop, J.E. (1973). Limnology of a small Malayan River, Sungai Gombak, Dr W.Junk. *The Hague*, pp: 129.

Cooper, J.E., J. Early and A.J. Holding (1991). Mineralization of dissolved organic phosphorus from a shallow eutrophic lake. *Hydrobiologia* 299: 89-94.

Darlington, P.E.C.H. (1977) Temporal and partial variation in benthic invertebrate fauna of lake George Uganda Rep, from *Journal of Zoology.* 181. 95-111.

Edokpayi, C.A., Okeniyi, J.C., Ogbeibu, A. E., and Osimen, E.C. (2000). The effect of human activities on the macrobenthic invertebrates of Ibiekuma stream Ekpoma, Nigeria. *Biosc. Res. Comm*. 12 (1): 79-87.

Egborge, A.B.M. (1977). The Seasonal variation and distribution of phytoplankton of the lake Asejire. A new impoundment in Nigeria. *Proceeding of International conference on Kainji Lake. University of Ife. The Ecology of Lake Kainji. University of Ife., Ile-Ife Nigeria.* pp.136-145.

…….(1979b). The seasonal variation and distribution of phytoplankton of the lake Asejire. A new impoundment in Nigeria. *Proceedings of International Conference On Kainji Lake & River Basin Development in Africa.* Ibadan. Vol. 1. 189-202.

……. (1979c). The effect of impoundment on the phytoplankton of the River Osun, Nigeria. *nova HEDNIGIA BAND XXX!, 1+2. BRAUNSCHNEIG.* 407-418.

…….. (1981). The composition, seasonal variation and distribution of zooplankton in Lake Asejire, Nigeria. *Revue de Zoologie 1frica.* 95, 135-79

Fagade, S.O. and Olaniyan, C.I.O. (1973). The food and feeding interrelationship of the fishes of Lagos Lagoon. *Journal of Fish Biology* 5: 205-227.

Imevbore and Bakare, (1970). The food and feeding habits of non-cichlid fishes of the River Niger in the Kainji Reservoir area in Kainji – a Nigerian made lake. *Kainji Lake Studies* volume 7 Ecology Ed. S.A. Visser pp.

Johnson, M.G. and R.O. Brinkhurst (1971). Benthic community metabolism in Bay of Quinte and Lake Ontario. *J. Fish. Res. Bd. Can*. 28: 1715-1725.

Mehmet, A., Mehmet, O., and Meral, O. (2002). The Benthic Macroinvertebrate Faauna of Sarikum Lake and Spring Waters (Sinop). *Turkish J. Marine Sciences* 8: 103 – 119.

Odum, E. P. (1971). *Fundamentals of Ecology*. Saunders Ltd, Philadelphia. 574p.

Ogari, J. and S. Dadzie (1987): The food of the Nile perch, Lates niloticus (L.), fter the disappearance of the haplochromine cichlids in the Nyanza Gulf of Lake Victoria (Kenya). *J.of Fish Biology*, 32(4): 571-577.

Ogbeibu, A.E. (2001). Distribution, density and diversity of dipterans in a tempoerary pond in Okomu Forest Reservoir, Souther Nigeria. *Journal of Aquatic Science*, 16: 43-52.

…… and Victor, R. (1989). The effects of road and bridge construction on the bank root marcrobenthic invertebrates of a southern Nigeria stream. *Environmental Pollution*, 56: 85-100.

…… and A.B.M. Egborge (1995). Hydrobiological studies of water bodies in the Okomu Forest Reserve (Sanctuary) in Southern Nigeria. I. Distribution and diversity of the invertebrate fauna. *Tropical Freshwater Biology* 4: 1-27.

……. and B.J. Oribhabor (2002). Ecological impact of river impoundment using benthic macroinvertebrates as indicators. *Water Research* 36: 2427 – 2436.

Oke, O.O. (1998): Plankton Diversity, abundance and productivity in the Owena Reservoir, South West Nigeria. Ph.D. Thesis. University of Ibadan. Ibadan.

Ormerod, S.J. (1988). The micro-distribution of aquatic macroinvertebrates in the Wye River system: the result of abiotic or biotic factors? *Freshwater Biology*, 20: 241-247.

…….. and Tyler, S.J. (1988). The diet of green sandpipers *Tringa ochropus* in contrasting areas of their winter range. *Bird study*. 35: 25-30.

Pennak, R.W. (1978). Freshwater Invertebrates of the United States. Wiley –Interscience Publication, New York, 803p.

Petr, T. (1970). Macroinvertebrates of flooded trees in man-made Volta Lake (Ghana) with special reference to the burrowing May Fly *Povilla adusta*. *Hydrobiologia* 36: 3-4.

Ugwumba, O.A. and Ikusemiju, K. (1994). The food and feeding habits of the non-cichlid fishes in the Lekki Lagoon Nigeria. *Nigeria Journal of Science.* 28: 357-368.

Umeozor, O.C. (1996). Influence of biotype salinity and biochemical oxygen demand on the composition and distribution of aquatic insects in New Calabar River. *Nigeria Tropical Freshwater Biology.* 5 : 31- 42

Victor, R. and Dickson, D.T. (1985). Macrobenthic invertebrates of a Pertubed stream in Southern Nigeria. *Environmental Pollution Series A.* 38: 99-107.

Victor, R. and Ogbeibu, A. E. (1985a). Macrobenthic invertebrates of a Nigerian stream flowing through farmlands in southern Nigeria. Environ. Pollut. (Ser. A)., 39: 337-349.

Victor, R. and Ogbeibu, A. E. (1985b). Recolonisation of macrobenthic invertebrates of a Nigerian stream after pesticide treatment and associated disruption. Environ. Pollut. (Ser. A). 41: 125-137.

. Yoloye, N.L (1994). *Basic Invertebrate Zoology*. Ilorin University Press. 180p.

Zabbey, N. (2002) An ecological survey of benthic macroinvertebrates of Woji Creek, off the Bonny River System. Rivers State. M.Sc. Thesis, University of Port- Harcourt. 102p.

Sikoki, F.D.and Zabbey, N. (2006). Environmental gradients and Benthic Community of the middle reaches of Imo River, South-Eastern Nigeria. *Environ. Ecol*., 24 (1): 32-36.

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Corresponding author
J.B. Edward
Department of Zoology, University of Ado Ekiti, P.M.B. 5363, Ado Ekiti Ekiti State, Nigeria